

State of California
AIR RESOURCES BOARD

EXECUTIVE ORDER D-266
Relating to Exemptions Under Section 27156
of the Vehicle Code

NITROUS OXIDE SYSTEMS, INC.
NITROUS OXIDE INJECTION KIT #5174, #5115, & #5115-II

Pursuant to the authority vested in the Air Resources Board (ARB) by Section 27156 of the Vehicle Code; and

Pursuant to the authority vested in the undersigned by Sections 39515 and 39516 of the Health and Safety Code and Executive Order G-45-5;

IT IS ORDERED AND RESOLVED: That the installation of the Nitrous Oxide Injection Kit #5174, #5115, & #5115-II manufactured by Nitrous Oxide Systems, Inc. have been found not to reduce the effectiveness of required motor vehicle pollution control devices and, therefore, are exempt from the prohibitions of Section 27156 of the Vehicle Code on kit #5174 for installation on 1992 Chevrolet Corvettes powered by the 5.7 liter LT-1 gasoline engine, and kit #5115 & #5115-II for installation on 1986 to 1992 Ford Mustangs & Thunderbirds, Lincoln MK VIIIs, and Mercury Cougars equipped with a 5.0L V-8 gasoline engine.

This Executive Order is valid provided that installation instructions for the Nitrous Oxide Injection Kit #5174, #5115, & #5115-II will not recommend tuning the vehicle to specifications different from those submitted by the device manufacturer.

Changes made to the design or operating conditions of the device, as exempted by the ARB, that adversely affect the performance of a vehicle's pollution control system shall invalidate this Executive Order.

Marketing of this device using an identification other than that shown in this Executive Order or marketing of this device for an application other than those listed in this Executive Order shall be prohibited unless prior approval is obtained from the Air Resources Board.

This Executive Order does not constitute any opinion as to the effect the use of this device may have on any warranty either expressed or implied by the vehicle manufacturer.

This Executive Order is granted based on results from emissions tests conducted in accordance with Cold-Start CVS-75 Federal Test Procedure. However, the ARB finds that reasonable grounds exist to believe that use of the Nitrous Oxide Injection Kit #5174, #5115, & #5115-II may adversely affect emissions of motor vehicles when operating under conditions outside the parameters of the previously prescribed test procedures. Accordingly, the ARB reserves the right to conduct additional emission tests, in the future, as such tests are developed, that will more adequately measure emissions from all cycle phases. If such test results demonstrate that the Nitrous Oxide Injection Kit #5174, #5115, & #5115-II adversely affect emissions during off-cycle conditions (defined as those conditions which are beyond the parameters of the Cold-Start CVS-75 Federal Test Procedure), this Executive Order shall be effectively rescinded as of the date the test results are validated. Further, if such test results or other evidence

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provides the ARB with reason to suspect that the Nitrous Oxide Injection Kit #5174, #5115, & #5115-II will affect the durability of the emission control system, Nitrous Oxide Systems, Inc. shall be required to submit durability data to show that the durability of the vehicle emission control system is not, in fact, affected and/or that the add-on or modified part demonstrates adequate durability.

In addition to the foregoing, the ARB reserves the right in the future to review this Executive Order and the exemption provided herein to assure that the exempted add-on or modified part continues to meet the standards and procedures of Title 13, California Code of Regulations, Section 2222, et seq.

THIS EXECUTIVE ORDER DOES NOT CONSTITUTE A CERTIFICATION, ACCREDITATION, APPROVAL, OR ANY OTHER TYPE OF ENDORSEMENT BY THE AIR RESOURCES BOARD OF ANY CLAIMS OF THE APPLICANT CONCERNING ANTI-POLLUTION BENEFITS OR ANY ALLEGED BENEFITS OF NITROUS OXIDE SYSTEMS, INC.'S NITROUS OXIDE INJECTION KIT #5174, #5115, & #5115-II.

No claim of any kind, such as "Approved by the Air Resources Board" may be made with respect to the action taken herein in any advertising or other oral or written communication.

Section 17500 of the Business and Professions Code makes untrue or misleading advertising unlawful, and Section 17534 makes violation punishable as a misdemeanor.


Section 43644 of the Health and Safety Code provides as follows:

"43644, (a) No person shall install, sell, offer for sale, or advertise, or, except in an application to the state board for certification of a device, represent, any device as a motor vehicle pollution control device for use on any used motor vehicle unless that device has been certified by the state board. No person shall sell, offer for sale, advertise, or represent any motor vehicle pollution control device as a certified device which, in fact, is not a certified device. Any violation of this subdivision is a misdemeanor."

Any apparent violation of the conditions of this Executive Order may result in its rescission or submission to the Attorney General of California for such action as he deems advisable.

The Bureau of Automotive Repair will be notified by copy of this order.

Executed at El Monte, California, this 7th day of July, 1992.


R. B. Summerfield
Assistant Division Chief
Mobile Source Division

State of California
AIR RESOURCES BOARD

EVALUATION OF NITROUS OXIDE SYSTEMS, INC.
NITROUS OXIDE SYSTEM, KIT #5174, #5115, & #5115-II FOR EXEMPTION FROM THE
PROHIBITIONS OF VEHICLE CODE SECTION 27156 IN ACCORDANCE WITH
SECTION 2222, TITLE 13, OF THE CALIFORNIA CODE OF REGULATIONS

July 1992

State of California
AIR RESOURCES BOARD

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NITROUS OXIDE SYSTEM, KIT #5174, #5115, & #5115-II FOR EXEMPTION FROM THE
PROHIBITIONS OF VEHICLE CODE SECTION 27156 IN ACCORDANCE WITH
SECTION 2222, TITLE 13, OF THE CALIFORNIA CODE OF REGULATIONS

by

Mobile Source Division
State of California
Air Resources Board
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(This report has been reviewed by the staff of the California Air Resources Board and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the Air Resources Board, nor does the mention of trade names or commercial products constitute endorsement or recommendation for use.)

SUMMARY

Nitrous Oxide Systems, Inc. has applied for an exemption from the prohibitions of Vehicle Code Section 27156 for their Nitrous Oxide System (NOS), kit #5174 for installation on 1992 Chevrolet Corvettes equipped with a 5.7L LT-1 V-8 gasoline engine, and kit #5115 & #5115-II for installation on 1986 to 1992 Ford Mustangs & Thunderbirds, Lincoln MK VIIs, and Mercury Cougars equipped with a 5.0L V-8 gasoline engine. Nitrous Oxide Systems, Inc. has submitted a completed application and all the required information, as well as exhaust catalysts temperature data.

Based on the submitted information and an engineering evaluation, the staff concludes that the installation of the Nitrous Oxide System, kit #5174, #5115, & #5115-II will not adversely affect exhaust emissions on the affected vehicles when tested in accordance with the Cold Start CVS-75 Federal Test Procedure.

The staff recommends Nitrous Oxide Systems, Inc. be granted an exemption as requested and that Executive Order D-266 be issued.

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NITROUS OXIDE SYSTEM, KIT #5174, #5115, & #5115-II FOR EXEMPTION FROM THE
PROHIBITIONS OF VEHICLE CODE SECTION 27156 IN ACCORDANCE WITH
SECTION 2222, TITLE 13, OF THE CALIFORNIA CODE OF REGULATIONS

I. INTRODUCTION

Nitrous Oxide Systems, Inc. of 5930 Lakeshore Dr., Cypress, California 90630, has applied for an exemption from the prohibitions of Vehicle Code Section 27156 for their Nitrous Oxide System (NOS), kit #5174 for installation on 1992 Chevrolet Corvettes equipped with a 5.7L LT-1 V-8 gasoline engine, and kit #5115 & #5115-II for installation on 1986 to 1992 Ford Mustangs & Thunderbirds, Lincoln MK VIIIs, and Mercury Cougars equipped with a 5.0L V-8 gasoline engine.

Nitrous Oxide Systems, Inc. has submitted a completed application and all the required information, as well as exhaust catalysts temperature data.

II. CONCLUSIONS

Based on the submitted information and an engineering evaluation, the staff concludes that the installation of NOS, kit #5174, #5115, & #5115-II will not adversely affect exhaust emissions from vehicles for which the exemption is requested when tested in accordance with the Cold Start CVS-75 Federal Test Procedure.

III. RECOMMENDATION

The staff recommends that Nitrous Oxide Systems, Inc. be granted an exemption as requested and that Executive Order D-266 be issued.

IV. NITROUS OXIDE SYSTEM DESCRIPTION

The Nitrous Oxide System (NOS) is specifically designed for installation on 1992 Chevrolet Corvettes that are equipped with a 5.7L LT-1 V-8 gasoline engine and 1986 to 1992 Ford Mustangs & Thunderbirds, Lincoln

MK VIIs, and Mercury Cougars equipped with a 5.0L V-8 gasoline engine. The kit uses the automotive grade chemical nitrous oxide to enhance the performance of the vehicles at wide open throttle (WOT) only.

The NOS kit can be separated into three main components: electrical, hardware, and gas. The electrical components include a WOT relay module, power relay, fuel pressure safety switch, flow solenoids, wiring harness, and arming switch. The WOT relay module is designed to detect a full throttle mode. This is achieved by the use of the OEM throttle position sensor (TPS) switch and its 0 to 5 volt output that is directly related to throttle position. A 0 voltage refers to the throttle plate at 0 degrees (closed), and a 4.8 to 5.0 volt reading is detected when the throttle plate is at 90 degrees (WOT). The WOT relay module is designed to monitor the signals out of the OEM TPS. When the relay module detects an output voltage in the range of 4.8 to 5.0, a signal is sent to the power relay to activate the flow solenoids. The WOT relay module is designed to buffer the signals that it monitors, allowing no distortion from the TPS to the electronic control unit. The power relay works as an electronic switch, checking for an "on" condition from the WOT relay module and arming switch before activating the flow solenoids. Both WOT relay module and arming switch have to be in the "on" condition in order to trigger the flow solenoids. A fuel pressure safety switch prevents the flow of nitrous oxide at the flow solenoid, should there be a fuel pump failure.

The hardware components of the nitrous oxide system can be broken down into two categories, primary and support. The primary components include the supply bottle, fuel pump, and injector. The supply bottle weighs 19 lbs. and can hold a maximum of 15 lbs. of nitrous oxide which translates to

a total bottle weighing 34 lbs. An emergency pressure relief valve, vented away from the passenger compartment, is incorporated with the supply bottle. On kit no. 5174 & 5115-II, the fuel pump is designed to increase fuel pressure from the stock 40-45 psi range to the 80-85 psi range at WOT. Also a #67 flare jet is used on those kits to deliver the nitrous oxide, the #67 refers to the orifice opening which is 67 thousandths of an inch. Kit #5115 uses the stock fuel pressure and a #42 flare jet. The support hardware includes reinforced tubing, associated brackets, and a bottle heater. The reinforced tubing runs from the supply bottle to the flow solenoids and then to the nitrous oxide injector. Typical brackets included in the kit are those used to support the bottle and flow solenoid. A bottle heater is installed around the supply bottle to maintain a 75 to 85 degrees Fahrenheit when required.

An automotive grade nitrous oxide which is a cryogenic gas consisting of two nitrogen molecules bonded to one oxygen molecule is used in the Nitrous Oxide System. This gas is sold and marketed under the brand name Nitrous Plus and is produced solely by Puritan Bennett. It differs from medical grade nitrous oxide in that it includes trace amounts of sulfur dioxide (5 ppm) to prevent substance abuse.

Under ambient pressure and temperature conditions, nitrous oxide exists in a gaseous state. In automotive applications, nitrous oxide is stored as a liquid in a DOT approved pressure vessel. Bottle pressure is kept in the 800-1000 psi range. As nitrous oxide is removed from the bottle the remaining supply of nitrous oxide undergoes a phase change (liquid converting to gas) to restore equilibrium in the bottle.

Nitrous Oxide Systems, Inc. requires that no changes be made in either the ignition timing or spark plug's gap; however, 92+ octane fuel is

required. They also provide a warning to consumers to not use this product in conjunction with any aftermarket PROM chip due to the potential effects on performance and vehicle durability.

V. DISCUSSION OF THE NITROUS OXIDE SYSTEM

An engineering evaluation was conducted on the NOS kit to determine its impact on vehicle emissions and durability.

A. Emission Impact

The NOS kit injects liquid nitrous oxide into the engine's intake tract when two conditions are satisfied: the arming switch is "on" and throttle is at the WOT position. Injecting nitrous oxide into the inlet tract of an engine produces a decrease in the engine's inlet air temperature due to the latent heat of vaporization caused by the injection of nitrous oxide into the air inlet track. Additionally, nitrous oxide is a stronger oxidizer than ambient air (36 percent oxygen by weight as compared to 21 percent oxygen by weight for ambient air). The combination of nitrous oxide and fuel result in a substantial increases in horsepower and torque when compared to the stock configuration. The manufacturer claims use of NOS kit #5174 & #5115-II will increase horsepower by 80 percent and kit #5115 by 60 percent.

Effective use of the NOS kit requires wide-open throttle operation. However, the Cold Start CVS-75 Federal Test Procedure (FTP), which is the official ARB test procedure for evaluating the emission impact of add-on or modified parts, does not take into account emissions during wide-open-throttle conditions. Testing the NOS kit using the CVS-75 FTP procedure will not show any effect on emissions because the kit will not be operational during the test cycle. The ARB is currently developing off-cycle testing to address the emission impact of devices such as the NOS kit

which operate only when outside of the CVS-75 FTP drive cycle. Until off-cycle procedures are developed, the impact of the NOS kit on vehicle emissions could not be determined.

The staff looked into potential chemical reactions which could occur when liquid nitrous oxide is injected into the inlet mixture. The manufacturer provided the following chemical reaction for nitrous oxide and iso-octane fuel during combustion.



This chemical equation represents complete combustion, which seldom happens under actual driving conditions. The staff is not aware of any studies conducted to date which shows the actual chemical reaction occurring in the vehicle's engine when injected with nitrous oxide. Studies conducted on stationary sources such as the petrochemical industry (their processes have waste gases containing high levels of nitrous oxide), have shown that nitrous oxide decomposes at sufficiently high temperatures to either nitric oxide (NO) or Nitrogen (N_2) and Oxygen (O_2). In the presence of rich fuel, NO reacts with hydrocarbon fragments to form intermediate species X-N (HCN + NH_3). Depending on the temperature and air/fuel conditions, remaining fuel fragments may be oxidized fully into CO_2 and H_2O and the nitrogen species (NH_3 , HCN or NO) may be reduced to molecular nitrogen or oxidized to NOx. These chemical reactions are likely to occur in a vehicle injected with nitrous oxide. However, without the proper test procedures, relative amounts of NOx and HC could not be quantified. The manufacturer stated use of nitrous oxide is minimal because of its high cost (\$2.50 per pound; a pound of nitrous oxide is approximately equivalent to 10 seconds of vehicle operation).

B. Durability

The staff also evaluated the NOS kit for its effect on the durability of the vehicle's emission control system, specifically the potential degradation of the oxygen sensor and the catalytic converter.

Nitrous Oxide Systems, Inc. (NOS, Inc.) conducted a literature search on all Society of Automotive Engineers (SAE) papers from 1965 to present regarding the performance of exhaust gas oxygen sensors. Based on the literature search, oxygen sensor failure could either be mechanical or chemical. Mechanical failure was attributed to external structural damage or internal separation of components caused by impact or excessive vibration. Chemical failure was attributed to poisoning due to presence of lead, phosphorus, zinc, calcium, or silica. Nitrous Plus (automotive grade nitrous oxide) contains no elements known to contribute any exhaust gas oxygen failure or performance degradation.

Degradation of the catalytic converter has been known to accelerate when exposed to sulfur. The sulfur content of current pump gasoline varies between 30 to 3000 ppm, whereas Nitrous Plus contains only 5 ppm. Therefore, based on comparative sulfur content, any degradation in the catalytic converter will be due to the sulfur content in the fuel. To demonstrate that the effect of sulfur from nitrous oxide injection is insignificant, NOS, Inc. conducted a mass flow analysis of fuel and nitrous oxide using a 1990 5.0L Mustangs and a 1991 5.0L Pontiac Firebird. Using typical customer usage rates (5 lbs/week), sulfur contributed by nitrous oxide injection would be between 1 to 2 percent of the total sulfur consumed by the vehicle.

The use of nitrous oxide can result in an increase in exhaust gas temperature, a factor critical to life expectancy and degradation of the

catalytic converter. Due to these concerns, NOS, Inc. volunteered to demonstrate that no substantial increase in exhaust temperature would be observed by conducting comparative exhaust temperature testing. Testing was conducted at the Los Angeles County Raceway in Palmdale, California with representatives from the ARB present to observe the tests. A 1992 Corvette and 1990 Mustang were used in the tests which consisted of four 0 to 80 miles per hour stand still to WOT drag strip style runs, two tests to record baseline temperatures and two tests to measure the modified temperatures. The test vehicles were equipped with data loggers to record the catalyst inlet and bed temperatures. Since testing was conducted on a drag strip and not under controlled laboratory conditions, the staff anticipated low repeatability of data. Also, the data logger is manually engaged/disengaged which could attribute to some variability in test data. Therefore, a temperature increase of up to 10 percent over the baseline was considered to be insignificant. Furthermore, staff deems the 0 to 80 MPH acceleration test to be the worst case condition, which will rarely occur when the vehicle is under normal street driving.

Results of the 0 to 80 MPH runs on the 1992 Corvette and the 1990 Mustang are shown in Appendix which demonstrates that no significant catalyst inlet or bed temperatures were observed from the use of the NOS kit. All catalyst bed temperatures recorded were far below the 1700 degrees F upper limit recommended by catalyst manufacturers.

Nitrous Oxide Systems, Inc. submitted all the required information and has met the requirements for an exemption.

APPENDIX

TABLE 1.

CORVETTE 80 MPH TEMPERATURE VALUES

<u>Test</u>	<u>Configuration</u>	<u>Inlet</u> (Degrees Fahrenheit)	<u>Bed</u>	<u>Catalyst</u>
#1	Baseline	1430	1430	Driver
#1	Baseline	1175	1044	Passenger
#2	Baseline	1456	1456	Driver
#2	Baseline	1192	1105	Passenger
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Average Baseline		1443	1443	Driver
		1184	1075	Passenger
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#3	Nitrous	1490	1561	Driver
#3	Nitrous	1245	1122	Passenger
#4	Nitrous	1474	1556	Driver
#4	Nitrous	1254	1254	Passenger
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Average Nitrous		1482	1559	Driver
		1250	1188	Passenger
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Difference		+39 or 3%	+116 or 8%	Driver
		+66 or 5%	+113 or 10%	Passenger
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MUSTANG 80 MPH TEMPERATURE VALUES

<u>Test</u>	<u>Configuration</u>	<u>Inlet</u> (Degrees Fahrenheit)	<u>Bed</u>	<u>Catalyst</u>
#1	Baseline	1509	1436	Pre-Cat Driver
#1	Baseline	1447	1447	" Passenger
#1	Baseline	1219	1106	Cat Driver
#1	Baseline	1105	964	" Passenger
#2	Baseline	1509	1437	Pre-Cat Driver
#2	Baseline	1465	1465	" Passenger
#2	Baseline	1236	1091	Cat Driver
#2	Baseline	1157	1013	" Passenger
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Average Baseline		1509	1436.5	Pre-Cat Driver
		1456	1456	" Passenger
Average Baseline		1227.5	1098.5	Cat Driver
		1131	988.5	" Passenger
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#1	Nitrous	1562	1467	Pre-Cat Driver
#1	Nitrous	1474	1340	" Passenger
#1	Nitrous	1149	1077	Cat Driver
#1	Nitrous	999	977	" Passenger
#2	Nitrous	1614	1614	Pre-Cat Driver
#2	Nitrous	1527	1457	" Passenger
#2	Nitrous	1228	1155	Cat Driver
#2	Nitrous	1078	1006	" Passenger
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Average Nitrous		1588	1540.5	Pre-Cat Driver
		1500.5	1398.5	" Passenger
Average Nitrous		1188.5	1116	Cat Driver
		1038.5	991.5	" Passenger
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Difference		+39 or 3%	+104 or 7%	Pre-Cat Driver
		+44 or 3%	-57 or -4%	" Passenger
Difference		-39 or -3%	+17 or 2%	Cat Driver
		-92 or -8%	+3 or 0.3%	" Passenger
